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New species and new records of buellioid lichens from islands of the South Pacific Ocean

John A. Elix

Research School of Chemistry, Building 137, Australian National University, Canberra, A.C.T. 2601, Australia
John.Elix@anu.edu.au

Abstract

Buellia rarotongensis Elix from Rarotonga, *Gassicurtia albomarginata* Elix from Vanuatu and *Monerolechia papuensis* Elix from Papua New Guinea and are described as new to science. In addition, *Buellia cranwelliae* Zahlbr. and *B. maunakeansis* Zahlbr. are reported as new to Norfolk Island, *Buellia bahiana* Malme and *Gassicurtia subpulchella* (Vain.) Marbach as new to Rarotonga, *Buellia polyxanthonica* var. *isidiata* Elix & Kantvilas, *B. spuria* var. *amblyogona* (Müll.Arg.) Elix and *Cratiria chloraceus* Marbach as new to Papua New Guinea and *Orcularia elixii* Kalb & Giralt as new to Hawai'i. *Buellia maunakeansis* is also reported from Australia.

Introduction

The genus *Buellia* includes a large, heterogeneous assemblage of mostly crustose lichens with a chlorococcoid photobiont, lecideine to biatorine apothecia, and usually *Bacidia*-type asci with 1-septate, dark-pigmented ascospores. Research on buellioid lichens over the last decade or so has led to the segregation of several well-defined groups of species as separate genera, particularly for the corticolous species (Marbach 2000). Thus *Buellia* in the strict sense is now limited to species with *Callispora*-type ascospores, bacilliform or weakly clavate conidia and a hymenium usually inspersed with oil droplets (Bungartz et al. 2007); that is, the so-called *Hafellia* group (Moberg et al. 1999). However, there is a large residue of often-unrelated taxa that cannot be assigned to any segregate genera at this stage and remain classified in *Buellia* in the broad sense. Resolving the taxonomy of the Physciaceae/Caliciaceae clearly remains a challenge because sometimes the traditional characters offer insufficient resolution. For a sound phylogenetic re-assessment it will be necessary to use molecular tools and examine a broad, representative range of the diverse species in this group. For the Australian species, a preliminary key to genera as well as detailed descriptions of many of the segregate genera has been published (Elix 2011).

In the most recent checklist of *the lichens of the smaller Pacific Islands*, a total of 87 taxa of *Buellia s.lat.* were recorded (Elix and McCarthy 2008). Over a third of these reports were from the Hawaiian Islands following the extensive studies by Zahlbruckner and Magnusson, and summarized in Magnusson's catalogue (Magnusson 1956). Records of *Buellia s.lat.* from Papua New Guinea can be found in Aptroot (2009), where a total of 18 taxa were listed. Since that time some additional species have been recorded for the islands, but not surprisingly several taxa have also been relegated to synonymy. In this paper, I describe three new species of buellioid lichens, one from each of Papua New Guinea, Rarotonga and Vanuatu, as well as some new records for the islands.

Methods

Observations and measurements of photobiont cells, thallus and apothecium anatomy, asci and ascospores were made on hand-cut sections mounted in water and dilute KOH (K). Asci were also observed in Lugol's Iodine (I), with and without pre-treatment in K. Medullary sections were treated with 10% sulfuric acid (H_2SO_4) and apothecial sections with 50% nitric acid (N). Chemical constituents were identified by thin-layer chromatography (Elix 2014) and comparison with authentic samples.

New Species

1. *Buellia rarotongensis* Elix, sp. nov.

MycoBank No.: MB 814614

Similar to *Buellia subcoronata* (Müll.Arg.) Malme but differs in having pruinose apothecia and in growing on rocks.

Type: Cook Islands: Rarotonga: Te Ko'u track, 21°13'S, 159°46'E, alt. 60-100 m, on volcanic rocks among taro plots, *P.M. McCarthy s.n.*, 7 Jun 1998 (holo: CANB).

Thallus of scattered squamules; squamules orbicular to somewhat irregular, 0.2–3 mm wide, up to 0.15 mm thick, often bearing a single apothecium; upper surface white to grey-white, plane to irregularly undulate; prothallus black or not apparent; medulla white, lacking calcium oxalate (H_2SO_4–), I–; photobiont cells 8–15 µm diam. *Apothecia* 0.1–0.5 mm wide, lecideine, immersed, erumpent, initially with an accessory thalline margin that is soon excluded, becoming broadly adnate; disc black, with dense thallus-coloured pruina particularly when young, disc plane or becoming weakly convex; proper margin thick, prominent, persistent, often higher than disc, in section 35–50 µm thick, outer zone dark brown, K+ forming red-orange needle-like crystals, paler brown within. *Epihymenium* 12–15 µm thick, pale brown to brown or orange-brown, K–, N–, with crystals that dissolve in K. *Hypothecium* 150–250 µm thick, deep red-brown to brown-black, K+ forming red-orange needle-like crystals. *Hymenium* 65–90 µm thick, colourless, not inspersed; subhymenium colourless to brown, 40–50 µm thick, K+ dark olive-brown; paraphyses 1.5–2 µm wide, simple to sparsely branched, apices 3–4 µm wide, with pale brown caps; asci of the *Bacidia*-type, with 8 or fewer spores. *Ascospores* 1-septate, olive-brown then brown, ellipsoid, juvenile spores *Pachysporaria*-type, mature spores *Buellia*-type, (10–)12–18 µm long, 5–8 µm wide, rarely constricted; outer spore-wall smooth to finely ornamented. *Pycnidia* rare, immersed; conidia bacilliform, 7–10 µm long, 0.5–0.7 µm wide.

Chemistry. Thallus K+ yellow then red, P+ yellow-orange, C–, UV–; containing atranorin (minor), norstictic acid (major), connorstictic acid (minor).

This new species belongs to *Buellia sens. lat.* (see above). *Buellia rarotongensis* is a very distinctive species, readily recognised by the minute, scattered, white to grey-white squamules or areoles, many of which bear a single apothecium, the erumpent apothecia which ultimately become broadly adnate, the grey-white pruinose discs and the presence of atranorin and norstictic acid. Morphologically this new species resembles *B. subcoronata*, a terricolous species common in the subarid areas of continental Australia. However, *B. subcoronata* differs in having larger apothecia 0.8–1.0 mm wide, with markedly convex, epruinose discs, somewhat larger ascospores, 12–20 µm long, 5–10 µm wide, and shorter, broader conidia, 4–6(–7) µm long, 1–1.2 µm wide (Elix 2011). The thallus of *B. maunakeansis* (described below) comprises continuous to dispersed, convex areoles which may become flattened and sublobate (the latter may resemble squamules). Like *B. rarotongensis* it has pruinose discs and contains norstictic acid but differs in having broadly adnate to sessile apothecia, shorter bacilliform conidia (4–6 µm long) and in containing additional 4,5-dichlorolichexanthone rather than atranorin. In some respects, *B. rarotongensis* also resembles *B. ryanii* Bungartz, a saxicolous species from North America. Both may have subsquamulose thalli and initially immersed apothecia, but *B. ryanii* differs in having epruinose discs, shorter *Buellia*-type ascospores (9–13 µm long), shorter bacilliform to ellipsoid conidia (2–5 µm long) and by lacking lichen substances.

Etymology: The species is named after its distribution.

Distribution and habitat: At present *B. rarotongensis* is known from two localities in Rarotonga where it occurs on volcanic rocks in regrowth woodland. Associated species included *Parmotrema saccatilobum* (Taylor) Hale, *Parmotrema reticulatum* (Taylor) M.Choisy and *Xanthoparmelia subramigera* (Gyeln.) Hale.

Specimen examined: Cook Islands: Rarotonga, Raemaru Track, upper level, 21°14'S, 159°49'W, 200 m alt., on basalt rocks on fern dominated slopes with scattered *Albizzia*, *J.A. Elix 42874,* 8 Jun 1998 (CANB).

Fig. 1. *Buellia rarotongensis* (holotype). Scale bar = 1 mm.

2. *Gassicurtia albomarginata* Elix sp. nov.

MycoBank No.: MB 814615

Similar to *Gassicurtia subpulchella* (Vain.) Marbach but differs in having apothecia with a pale proper margin and epruinose discs and in containing 6-*O*-methylthiophanic acid.

Type: Vanuatu: Espiritu Santo: Logging Area near Lavatmas (N of Sara), 48 km NNW of Luganville, 15°07'S, 167°01'E, alt. 300 m, on upper branches of large felled *Endospermum medullosum* in poor lowland forest on flats, *Endospermum medullosum, Antiaris toxicarya, Pometia pinnata* dominated, *H. Streimann 62801 & P. Ala*, 22 Oct 1998 (holo: CANB; iso: B).

Thallus crustose, continuous, to 4 mm wide, rimose-areolate, areoles 0.5–0.1 mm wide; upper surface pale whitish grey to greenish white, smooth to finely granular or becoming sorediate; individual granules rounded, plane to weakly convex, 0.05–0.08 mm wide; prothallus black, in part surrounding the thallus; photobiont cells 8–13 µm wide; medulla white, I–. *Apothecia* 0.05–0.3 mm wide, lecideine, scattered, round, immersed to broadly adnate or rarely sessile; disc black, epruinose, weakly concave to plane; proper margin thick, persistent, glossy, raised above the disc, pale whitish grey to black, in section 40–50 µm thick, brown-black in the outer part, K– or K+ pale yellow solution, paler to colourless within. *Hypothecium* 120–170 µm thick, brown to dark brown or brown-black. *Epihymenium* 8–12 µm thick, pale olive-brown to dark brown, K–, N–. *Hymenium* 50–90 µm thick, colourless, not inspersed with oil droplets; paraphyses 1.5–1.7 µm wide, simple to sparsely branched, apices, 3–3.5 µm wide, with brown caps; *asci* of the *Bacidia*-type, 8-spored. *Ascospores* of the *Buellia*-type, 1-septate, olive-green to brown, narrow ellipsoid, (8–)10–13(–15) µm long, (3.5–)4–5(–6) µm wide, not curved, rarely constricted at the septum; outer spore-wall finely ornamented. *Pycnidia* not seen.

Chemistry: Thallus and medulla K–, C + orange, P–, UV+ orange; containing 6-*O*-methylthiophanic acid (major), thiophanic acid (major or minor), arthothelin (minor).

Species of *Gassicurtia* are characterized by crustose thalli, which may be areolate, verrucose, granular or coralloid, by having *Bacidia*-type asci, elongate fusiform conidia, 5–10 µm long, a non-inspersed hymenium, small *Buellia*-type ascospores that lack wall-thickenings at maturity (Marbach 2000, Elix 2011) and often contain red pigments. *Gassicurtia albomarginata* resembles *G. subpulchella*, a corticolous montane-tropical species known from Africa, Asia, North and South America (Marbach 2000) and Queensland (Elix 2011). Morphologically *G. subpulchella* differs in having pruinose discs with a black proper margin more or less level with the disc rather than a pale, elevated proper margin. In addition, *G. subpulchella* has somewhat larger apothecia 0.3–0.5 mm wide. Both species are characterized by the presence of thiophanic acid and arthothelin, but *G. subpulchella* contains minor amounts of 3-*O*-methylthiophanic acid rather than 6-*O*-methylthiophanic

acid. *Gassicurtia pseudosubpulchella* Marbach is also morphologically similar but can readily be distinguished by its esorediate upper surface and the K+ purple proper exciple (Marbach 2000). *Gassicurtia albomarginata* could also be confused with *Amandinea efflorescens* var. *pseudohypopelidna* Marbach, a corticolous species from New Caledonia (Marbach 2000). Both taxa have a sorediate upper surface, similarly sized *Buellia*-type ascospores and contain xanthones. Like *G. subpulchella, A. efflorescens* var. *pseudohypopelidna* differs from *G. albomarginata* in having apothecia with a black proper margin more or less level with the disc rather than a pale, elevated proper margin. Further, although both species contain thiophanic acid and arthothelin, *A. efflorescens* var. *pseudohypopelidna* differs in containing major quantities of thuringione as well as minor amounts of 3-*O*-methylthiophanic acid.

Etymology: The specific epithet refers to the pale proper margin of the apothecia of this species.

Distribution and habitat: At present, this new species is known only from the type locality. Associated species included *Graphis ceylanica* Zahlbr., *G. subserpentina* Nyl., *Leiorreuma exaltatum* (Mont. & Bosch) Staiger, *Parmotrema neocaledonicum* (Nyl.) Elix, *P. saccatilobum* (Taylor) Hale, *P. tinctorum* (Despr. ex Nyl.) Hale and *Thecaria montagnei* (Bosch) Staiger.

Fig. 2. *Gassicurtia albomarginata* (holotype). Scale bar = 1 mm.

3. *Monerolechia papuensis* Elix, sp. nov.

MycoBank No.: MB 814616

Similar to *Monerolechia norstictica* Elix but differs in having larger squamules, longer ascospores and in containing additional 4,5-dichlorolichexanthone.

Type: Papua New Guinea: Central Province: Hombrom Bluff, 25 km NE of Port Moresby, 9°24'S, 147°20'E, alt. 650 m, on exposed conglomerate outcrop in *Eucalyptus* dominated savannah woodland, *H. Streimann 14994 & E.K. Naoni,* 10 Feb 1991 (holo: CANB; iso: B).

Thallus autonomous or initially parasitic on various *Pertusaria* or *Pyxine* species, areolate, subsquamulose or becoming distinctly squamulose, squamules discrete, somewhat irregular, margin lobate, brown, 0.5–1.5 mm wide, up to 0.1 mm thick; upper surface brown, plane to irregularly undulate; prothallus black, prominent, surrounding and between squamules or not apparent; medulla white, lacking calcium oxalate (H_2SO_4–), I–; photobiont cells 8–13 µm diam. *Apothecia* 0.3–0.7 mm wide, lecideine, initially immersed, but soon broadly adnate to sessile; disc black, epruinose, weakly concave to weakly convex; proper margin concolorous with disc, persistent or excluded in older, convex apothecia, in section 50–60 µm thick, outer zone brown-black, K+ forming red-orange needle-like crystals, paler brown within. *Epihymenium* 10–15 µm thick, dark brown, K–, N–. *Hypothecium* 185–210 µm thick, dark brown to brown-black, K+ forming red-orange needle-like crystals. *Hymenium* 45–60 µm thick, colourless, not inspersed; paraphyses 1.5–2 µm wide, simple to sparsely branched, with apices 3–4.5 µm wide and brown caps; asci approximating the *Lecanora*-type, with 8 or fewer spores. *Ascospores* 1-septate, olive-brown then brown, ellipsoid, juvenile spores *Pachysporaria*-type, mature spores *Physconia*- then *Buellia*-type, 12–17(–22) µm long, 5–7.5(–9) µm wide, not constricted; outer spore-wall smooth to finely ornamented. *Pycnidia* rare, immersed; conidia bacilliform, 3–4 µm long, 1 µm wide.

Chemistry. Thallus K+ yellow then red, P+ yellow-orange, C–, UV+ orange; containing 4,5-dichlorolichexanthone (minor), norstictic acid (major), connorstictic acid (minor).

Species of *Monerolechia* are characterized by thalli that are initially parasitic on various other lichens (particularly *Pertusaria* species) but become autonomous, in having asci approximating the *Lecanora*-type, short, bacilliform conidia 3–6 µm long, a non-inspersed hymenium, and small *Buellia*-type ascospores which lack wall-thickenings at maturity (Marbach 2000, Kalb 2004, Elix 2015). *Monerolechia papuensis* closely resembles *M. norstictica* as both species have autonomous squamulose or subsquamulose thalli of bullate areoles. *M. papuensis* is further characterized by the broadly adnate to sessile, lecideine apothecia, the epruinose discs, short bacilliform conidia and the presence of 4,5-dichlorolichexanthone, norstictic and connorstictic acids. *Monerolechia norstictica* differs from *M. papuensis* in having smaller squamules, 0.1–0.5 mm wide, shorter ascospores, 10–15 µm long, 5–7 µm wide, and in containing only norstictic and connorstictic acids (Elix 2015). In overall morphology this new species also resembles the cosmopolitan, *M. badia* (Fr.) Kalb. The initially parasitic thalli of both species become autonomous with a crustose thallus of bullate areoles with a chocolate-brown upper surface or become subsquamulose or squamulose. The two species have very similar apothecia, ascospores and conidia but can readily be differentiated chemically since *M. badia* lacks lichen substances. The substances present in *M. papuensis* are definitely not derived from any parasitized species and can readily be detected in sections of the apothecia or squamules by treatment with K (turning orange with formation of red crystals).

Etymology: The species is named after the type locality.

Distribution and habitat: At present *B. papuensis* is known from two localities in Papua New Guinea where it occurs on siliceous rocks. Associated species included *Parmotrema praesorediosum* (Nyl.) Hale, *Pertusaria xanthodactylina* A.W.Archer & Elix and *Pyxine sorediata* (Ach.) Mont.

Specimens examined: Papua New Guinea: Central Province: type locality, on exposed conglomerate outcrop in *Eucalyptus* dominated savannah woodland, *H. Streimann 14993 & E.K. Naoni,* 10 Feb 1981 (B, CANB, LAE); Morobe Province: Heads Hump, 5 km SE of Bulolo, 7°13'S, 146°41'E, alt. 800 m, on rock outcrop in *Imperata* dominated grasslands, *H. Streimann 33451,* 16 Apr 1983 (B, CANB).

Fig. 3. *Monerolechia papuensis* (holotype). Scale bar = 2 mm.

New Records

1. *Buellia bahiana* Malme, *Arkiv för Botanik* 21A: 17 (1927)

This pantropical species has been reported from Africa, Australia, North, Central and South America and the Pacific including Hawai'i, Tahiti and New Caledonia (Elix 2009). It is characterized by the white, grey-white or pale grey crustose thallus, the 8-spored asci, the K+ violet epihymenium, the densely inspersed hymenium, the relatively small ascospores, 13–20 µm long, 5.5–8.0 µm wide, with subapical and septal wall thickenings and a smooth outer surface, and by the presence of norstictic acid. A detailed description is given in Elix (2009).

Specimen examined: Cook Islands: Rarotonga, Avana, 21°14'41"S, 159°43'55"W, alt. 10 m, on rotted coconut stump in roadside garden, *J.T. Swarbrick L.162F-Cl,* 28 Jun 2009 (CANB).

2. *Buellia cranwelliae* Zahlbr., *Denkschriften der Akademie der Wissenschaften in Wien mathematisch-naturwissenschaftliche Klasse* 104: 375 (1941)

This species was previously known only from New Zealand (Galloway 2007). It is characterized by the white crustose thallus which may become sublobate or placodiform at the margins, a white medulla containing calcium oxalate (H_2SO_4+), 8-spored asci, a dark brown, N+ greenish-black excipulum, *Physconia*- then *Buellia*-type, 1-septate, olive-brown to brown, ellipsoid, ascopores (10–)11–16(–18) µm long, 5–8(–10) µm wide, which are rarely weakly constricted at the septum and have a smooth outer wall and the straight, bacilliform, conidia, 3–5 µm long. The thallus lacks lichen substances. An amended description of this species follows.

Thallus crustose, rimose to areolate, to 15 mm wide; individual areoles usually convex, 0.4–2 mm wide and to 1.5 mm thick, dispersed or becoming contiguous to form a more or less continuous thallus, ±becoming sublobate or placodiform at the margins; upper surface white to grey-white, smooth or slightly uneven; prothallus brown, marginal or not apparent; cortex *c.* 10 µm thick; medulla white, containing calcium oxalate (H_2SO_4+), I–; photobiont cells 8–12 µm diam. *Apothecia* 0.4–0.8 mm wide, lecideine, scattered or crowded, mainly broadly adnate, ±round but often distorted by mutual pressure when crowded; disc black, epruinose, ±plane to markedly convex; proper exciple thin, concolorous with the disc, entire but soon excluded, in section 30–50 µm thick, outer zone dark brown to brown-black, in part K+ deep yellow solution, N+ greenish-black, inner zone paler brown. *Hypothecium* 45–55 µm thick, brown, K–. *Epihymenium* 8–12 µm thick, dark red-brown, K–, N–. *Hymenium* 60–75 µm thick, colourless, not or finely inspersed; paraphyses 1.7–2.0 µm wide, simple to branched, with apices 3.5–5 µm wide and dark brown caps; asci *Bacidia*-type, with 8 or fewer spores. *Ascospores* at first of the *Physconia*-type, then of the *Buellia*-type, 1-septate, olive-brown to brown, ellipsoid,

(10–)11–16(–18) µm long, 5–8(–10) µm wide, rarely weakly constricted at the septum; outer spore-wall smooth. *Pycnidia* immersed, ostioles black. Conidia bacilliform, straight, 3–5 µm long, 1–1.2 µm wide.

Chemistry. Thallus K–, P–, C–, KC–, UV–; no lichen substances detected.

Specimen examined: Norfolk Island: Rocky Point, Rocky Point Reserve, 29°03'S 167°55'E, alt. 40 m, on volcanic rocks along cliff tops, *J.A. Elix 18536 p.p. & H. Streimann*, 5 Dec 1984 (CANB).

Fig. 4. *Buellia cranwelliae* (*H.Mayrhofer 12269* in GZU). Scale bar = 1 mm.

3. ***Buellia maunakeansis*** Zahlbr., *Annales Mycologici* 10: 383 (1912)

This species was previously known from Hawai'i (Magnusson 1955). The thallus of this species comprises contiguous to dispersed, convex areoles which become ±flattened, more or less continuous and sublobate and bear black, broadly adnate to sessile apothecia. The thallus contains 4,5-dichlorolichexanthone, norstictic and connorstictic acids. An amended description of this species follows.

Thallus crustose, areolate, continuous to dispersed, up to 35 mm wide; individual areoles 0.4–2.0 mm wide and high, markedly convex and dispersed, sometimes only weakly convex and becoming contiguous to form a more or less continuous thallus; upper surface white to pale grey, smooth and shiny, rimose or subgranular; prothallus not apparent; medulla white, containing calcium oxalate (H_2SO_4+), I–; photobiont cells 7–11 µm diam. *Apothecia* 0.4–1.0 mm wide, lecideine, scattered, mostly broadly adnate, rarely sessile; disc black, rusty brown pruinose when young, ±plane to markedly convex; proper exciple thin, concolorous with the disc, entire but soon excluded, in section 35–55 µm thick, outer zone opaque brown-black, K+ orange with formation of red crystals, N–, inner zone red-brown. *Hypothecium* 200–250 µm thick, intense red-brown to brown-black, K+ orange with formation of red crystals. *Epihymenium* 10–12 µm thick, dark red-brown, K–, N–. *Hymenium* 70–90 µm thick, colourless, not inspersed; subhymenium colourless to red-brown, 40–65 µm thick; paraphyses 1.7–2.0 µm wide, simple to branched, capitate, with apices dark brown, 3.5–5 µm wide; asci approximating the *Bacidia*-type, with 8 or fewer spores. *Ascospores* at first of the *Physconia*-type, then of the *Buellia*-type, 1-septate, olive-brown to brown, ellipsoid, 11–20 µm long, 6–10 µm wide, sometimes ± constricted at the septum; outer spore-wall smooth. *Pycnidia* immersed; conidia bacilliform, straight, 4–6 µm long, 1–1.2 µm wide.

Chemistry. Thallus K+ yellow then red, C–, P+ orange: containing 4,5-dichlorolichexanthone (minor), norstictic acid (major), connorstictic acid (minor).

Specimens examined: Australia: Queensland: Noosa Heads National Park, Devils Kitchen Track, 26°23'S, 153°06'E, alt. 15 m, on rocks on exposed headland, *J.A. Elix 10351,* 29 Jul 1982, (B, CANB), *J.A. Elix 10389,* 2 Sep 1982 (CANB).

Norfolk Island: Rocky Point, Rocky Point Reserve, 29°03'S, 167°55'E, alt. 40 m, on volcanic rocks along the cliff tops, *J.A. Elix 18532 pr.p., 18536A,* 5 Dec 1984 (CANB); Point Blackburne Reserve, 29°02'30"S, 167°59'30"E, alt. 2 m, on exposed boulder facing sea amongst dense shrubs, *H. Streimann 34201*, 4 Dec 1984 (CANB).

United States of America: Hawai'i: Oahu, Kailua Beach Reserve, 21°24'N, 157°44'W, alt. 2 m, on volcanic rocks along the foreshore, *J.A. Elix 13517,* 9 Jul 1983 (CANB).

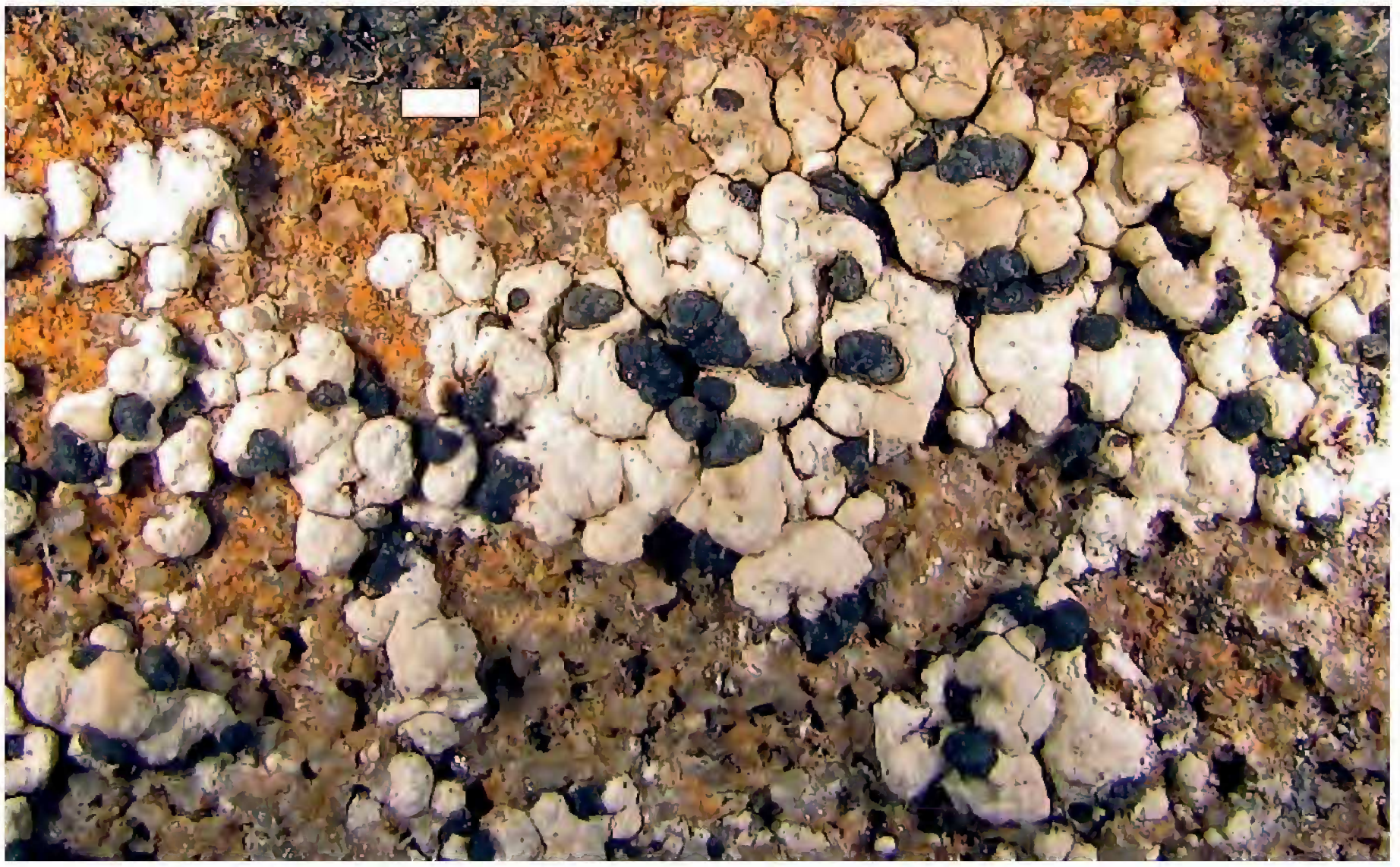

Fig. 5. *Buellia maunakeansis* (*Elix 10351* in CANB). Scale bar = 1 mm.

4. ***Buellia polyxanthonica*** var. ***isidiata*** Elix & Kantvilas, *Australasian Lichenology* 73: 31 (2013)

This taxon, previously known from tropical Australia (Elix & Kantvilas 2013), is characterized by the yellow to dull or deep yellow-green, crustose, rimose-areolate thallus with an isidiate upper surface, black, lecideine, broadly adnate to sessile apothecia, 0.1–0.4 mm wide, brown, 1-septate, *Physconia*- then *Buellia*-type ascospores, 12–20 µm long, 5–8 µm wide, and the presence of thiophanic and 3-*O*-methylthiophanic acids. A detailed description is given in Elix & Kantvilas (2013).

Specimen examined: Papua New Guinea: National Capital Province Province: Rea Rea Road, 17 km NW of Port Moresby, 9°23'S, 147°03'E, alt. 30 m, on small rock outcrop in *Eucalyptus* dominated savannah woodland, *H. Streimann 16372 & E.K. Naoni,* 15 Feb 1981 (CANB, LAE, H, UPNG).

5. ***Buellia spuria*** var. ***amblyogona*** (Müll.Arg.) Elix, *Australasian Lichenology* 65: 16 (2009)

This taxon is very common on rocks in mainland Australia and is also known from Lord Howe Island, Norfolk Island (McCarthy 2015) and New Zealand (Elix et al. 2015). It is characterized by the whitish to grey-white or grey, crustose thallus, usually with a prominent black prothallus, an amyloid medulla, the immersed then broadly adnate to sessile, rounded apothecia, a partly aeruginose, N+ red-violet to red-brown epihymenium, *Buellia*-type ascospores, 9–16 µm long, 4.5–7.5 µm wide, which rarely become constricted at the septum, bacilliform conidia 4–6 µm long, 1–1.5 µm wide, and the presence of atranorin and norstictic acid. It is distinguished from the superficially similar *B. homophylia* by the smaller spores and from *Buellia spuria* (Schaer.) Anzi var. *spuria* by containing norstictic acid rather than stictic acid as the major secondary metabolite. A detailed description is given in Elix (2011).

Specimens examined: Papua New Guinea: National Capital Province: near Buruni Village, 9°26'S, 147°08'E, alt. 100 m, on exposed rock outcrop in savannah woodland, *H. Streimann 14623A,14624A & A. Vinas,* 6 Feb 1981 (CANB). Morobe Province: Heads Hump, 5 km SE of Bulolo, 7°13'S, 146°41'E, alt. 800 m, on rock outcrop in *Imperata* dominated grasslands, *H. Streimann 33451A,* 16 Jun 1983 (CANB).

6. *Cratiria chloraceus* Marbach, *Bibliotheca Lichenologica* 74: 175 (2000)

This species was known previously from New Caledonia (Marbach 2000). It is characterized by the pale yellow to yellow-grey thallus, the yellow-pruinose apothecia, 1-septate, *Cratiria*-type ascospores, 14–20 × 6–8 µm, an excipulum that reacts K+ giving a intense red-violet solution, an inspersed hymenium and by the presence of arthothelin and thuringione. This taxon may contain arthothelin (major), thuringione (major or minor), 4,5-dichloronorlichexanthone (minor), ±6-*O*-methylarthothelin (minor). The closely related *Cratiria aggrediens* (Stirt.) Marbach is distinguished by its larger ascospores, 17–28 × 8–13 µm, and an excipulum that reacts with K giving an orange-red solution. A full description is given in Marbach (2000).

Specimen examined: Papua New Guinea: Morobe Province, Tauri River, Menyamya, 7°07'S, 145°59'W, alt. 1200 m, on planted *Casuarina* trunk at the settlement, in grasslands with some regrowth species, *H. Streimann 18943,* 29 Apr 1982 (CANB).

7. *Gassicurtia subpulchella* Malme, (Vain.) Marbach, *Bibliotheca Lichenologica* 74: 244 (2000)

Gassicurtia subpulchella is characterized by the yellow-grey, yellow or grey-white, warty or subgranular thallus, the grey, pruinose apothecia, the 8-spored asci, the olive to olive brown, to grey-olive, 1-septate ascospores 10–15 µm long, 4.0–5.5 µm wide and by the presence of thiophanic acid (major), arthothelin (trace), 3-*O*-methylthiophanic acid (trace), atranorin (trace) and an unknown red pigment. The proper exciple of the apothecia react K+ yellow. This species was known previously from Asia, Africa, North and South America (Marbach 2000), Queensland and Lord Howe Island (McCarthy 2015). Detailed descriptions are given in Marbach (2000) and Elix (2011).

Specimen examined: Cook Islands: Rarotonga, Raemaru Track, slope near summit cliff, 21°13'S, 159°48'W, alt. 270 m, on dead wood in open tropical woodland, *J.A. Elix 42874,* 8 Jun 1998 (CANB).

8. Orcularia elixii Kalb & Giralt, *Phytotaxa* 38: 56 (2011)

Orcularia elixii is characterized by the grey to brownish grey, thin, crustose thallus, the small, adnate to sessile lecideine apothecia, the 8-spored asci, the pale brown, 1-septate, *Orcularia*-type ascospores, 10–16 µm long, 5–8 µm wide, and by the absence of lichen substances. This species is close to *Orcularia insperata* (Nyl.) Kalb & Giralt but is distinguished by the smaller ascospores with larger lumina. It was previously known only from the type collection from eastern New South Wales (Kalb and Giralt 2011). A detailed description is given in Kalb & Giralt (2011).

Specimen examined: United States of America: Hawai'i: Oahu, Kailua Hills, 16 km NE of Honolulu, 21°23'N, 157°46'W, alt. 160 m, on *Acacia formosana* in *Leucina* scrub, *J.A.Elix 13603,* 11 Jul 1983 (B, CANB), growing together with *Buellia conspirans* (Nyl.) Vain.

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